EXPERIMENTER'S CORNER

Solderless Breadboards for Experimenters

By Forrest M. Mims

THE INVENTION of solderless breadboards has played an essential role in the evolution of modern solid-state electronics. Before such breadboards became available, experimental and prototype circuits had to be laboriously assembled using point-to-point wiring and soldered connections. Needless to say, circuit changes were difficult and time-consuming.

A little more than a decade ago, Barry Instrument Corporation introduced the Springboard®, a plastic base containing 120 rectangular slots. In each slot was a 0.3" long spring. Component leads and wires were inserted into the springs by means of an awl-like tool that opened a space in any desired spring.

I assembled hundreds of transistor circuits much faster than ever before with the help of a Springboard. The board still comes in very handy for prototyping circuits that have oversize leads such as heavy-duty rectifiers and SCRs. Unfortunately, the Springboard is not suitable for use with much smaller pins and leads of integrated circuits.

Wire-Wrappable Panels. Eventually several clever solderless breadboards were developed specifically for ICs. Among these were expensive wire-wrapping panels. Still available today in numerous styles and configurations, wire-wrappable panels have rows of IC sockets on one side. The other side contains matching rows of square cross-section pins extending from the sockets. Circuits are assembled by installing the required chips and making the necessary interconnections with wrapping wire.

Wire-wrappable panels and boards are available from many companies. Among those whose products are sold to experimenters and hobbyists are Vector Electronics, Inc. (12460 Gladstone Ave., Sylmar, CA 91342) and Cambion (Cambridge Thermionic Corporation, 445 Concord Ave., Cambridge, MA 02238). Both these companies make a wide assortment of pre-assembled wire-wrapping boards as well as perforated boards into which compatible wire-wrappable terminals and sockets can easily be installed.

The Electronic Products Division of the 3M Company (3M Center, St. Paul, MN 55101) has developed a particularly interesting do-it-yourself breadboarding system. The system uses unique dual-contact IC sockets that will accept an IC pin from one side and a plug strip pin from the other. The sockets are placed on a perforated card and secured in place by plug strips inserted into the back of the socket from the opposite side of the card. Interconnections are made with the help of an insertion tool that forces insulated wire into the U-shaped slots in the ends of the plug strip terminals.

3M has combined an assortment of dual-contact IC sockets and plug strips in its Scotchflex 3303 Breadboard Kit. This kit also includes a wire insertion tool, socket extraction tool, a cleverly designed plug-strip break-off tool, and a spool of connection wire.

You can easily custom design your own breadboards using hardware from Vector, Cambion, 3M, and other companies. Or you can improvise by installing rows of wire-wrappable IC sockets in a standard perfboard having copper solder pads at each hole (Radio Shack 276-152 or similar). Solder the socket's corner pins to the copper pads and the board is ready to use. Alternatively, you can use a standard (copperless) board and secure the sockets to it with a thin bead of cyanoacrylate cement.

Wire-wrappable panels are excellent for prototyping complex digital circuits of a repetitive nature such as large-capacity, solid-state memories. In fact, assembled wire-wrapped boards can even be used in permanent applications. Because of the difficulty of making changes, however, they aren't suitable for developing and experimenting with most analog/linear circuits and experimental logic circuits.

Plastic Solderless Breadboards. The plastic solderless breadboard has become an indispensable item on every electronic experimenter's workbench. AP Products, Inc. (1359 West Jackson St., Painesville, OH 44077) originated the concept of a solderless, plug-in breadboard. In addition to AP Products, major solderless breadboard makers include Vector Electronics, Global Specialties Corporation (70 Fulton Terrace, PO Box 1942, New Haven, CT 06509), and E&L Instruments (61 First St., Derby, CT 06418).

Figure 1 is a photograph of some of the solderless breadboard elements

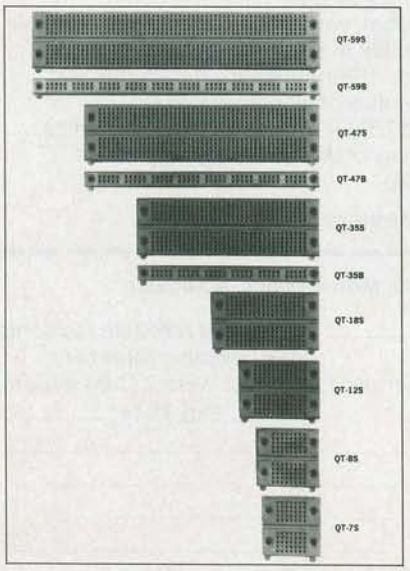

Fig. 1. Solderless breadboards available from Global Specialties.

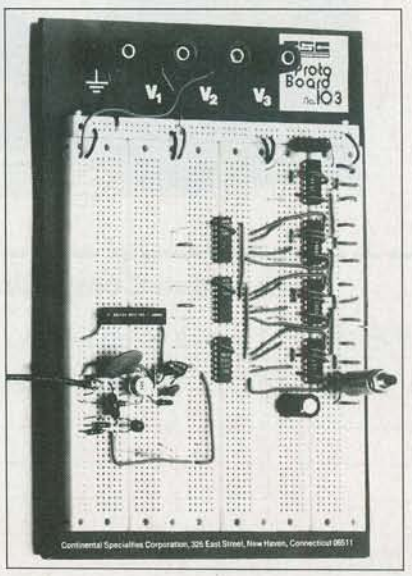

Fig. 2. Global's Proto-Board 103 has 2250 connection points.

made by Global Specialties. Similar in configuration to competing modules, each breadboard element includes parallel arrays of five common tie-points. Inside the five socket holes at each row of tie-points is a replaceable spring clip having precision-formed, nickel-silver contacts. The result is five physically independent but electrically common socket hole tie-points that accept wire leads having a diameter of 0.015" to 0.033". The contact resistance of each connection point is under 0.005 ohm.

Some solderless breadboards are configured as modules that include two or more rows of bus connection points across both sides of the breadboard. Others require separate plastic bus strips. Most modules snap or clip together to form arrays of modules.

Most manufacturers of solderless breadboards make various breadboard assemblies or prototyping systems. Figure 2, for example, shows a Global Specialties Proto-Board 103. Measuring 6" × 9", the PB-103 includes eight separate plastic breadboards installed on an aluminum panel having rubber feet. Four power-supply binding posts are included. The 450 common terminals of the PB-103 have a total of 2250 connection points (socket holes). The company also manufactures other breadboard assemblies with fewer or considerably more connection points.

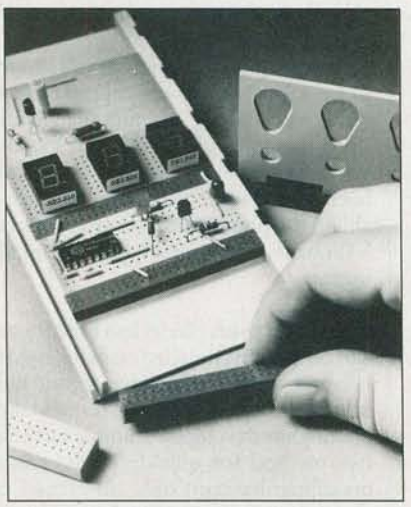

Fig. 3. AP Products' Hobby-Blox panels are installed in a tray.

Prototyping systems that include built-in power supplies and other circuit design aids are made by several companies. Among those made by E&L Instruments, for example, is the CD-1 CMOS/TTL Designer. This compact console-style prototyping tool, which is designed around a single solderless breadboard, includes a 5-V fixed supply, a variable 3-to-15-V supply, an adjustable frequency (1 Hz, 10 Hz, 100 Hz, 1 kHz, 10 kHz and 100 kHz) logic clock, four CMOS/TTL compatible LED indicators, and various switches, binding posts, and connectors. Though sophisticated prototyping systems like the CD-1 are expensive, they provide an unprecedented degree of circuit design flexibility.

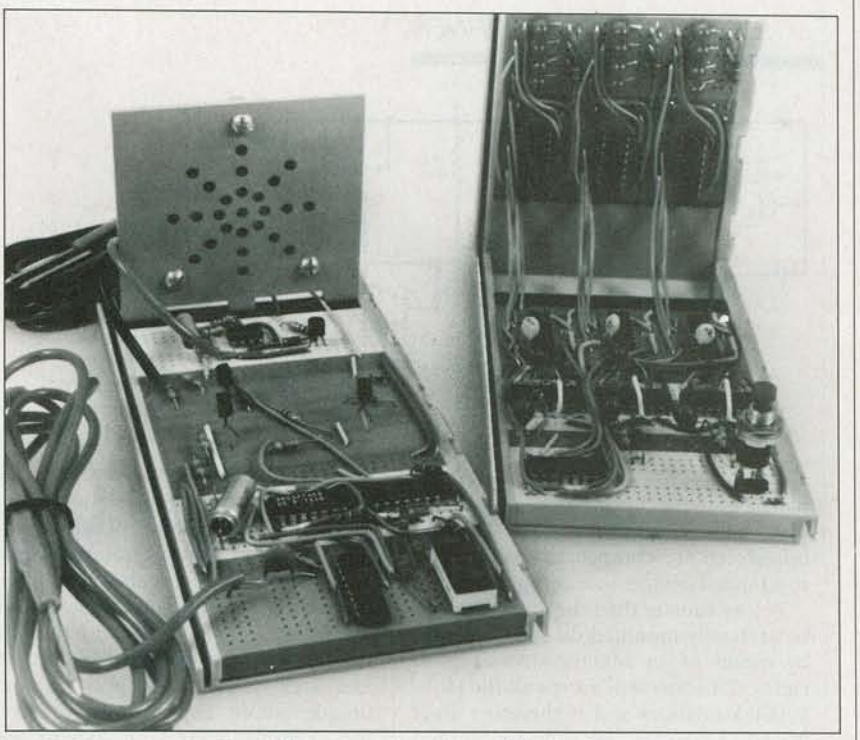

Fig. 4. Two examples of use of Hobby-Blox.

A New Modular Breadboarding System. AP Products has a Hobby-Blox™ family of compatible solderless breadboard products designed specifically for experimenters. Ideally suited for this use, the Hobby-Blox system is designed around a sturdy plastic tray into which various color-coded bus strips, solderless breadboard strips, and spacers can be installed as shown in Fig. 3. The tray will also accept a binding post strip and an exceptionally well-designed 9-V battery holder.

All the Hobby-Blox breadboards include row and column index markings. Two types are designed specifically for ICs or digital readouts. A third is designed for discrete components. A 6-position LED strip is also available.

The most notable feature of the Hobby-Blox system is its flexibility. Breadboard strips, spacers, and other members of the family can be installed in any desired arrangement. One or more additional trays can be added to the main tray with the help of an interlocking bus strip containing 60 connection points or a simple tray extender clip.

Even more important is the ability to install vertical panels that extend upward from the tray as shown in Fig. 4. These include a speaker panel with preformed holes (Fig. 4, left) and a control panel with six holes for installing switches, potentiometers, and indicator LEDs or lamps (see Fig. 3, right). Blank panels are available for custom designs. All these panels are mounted by inserting their three extensions into the slots in a spacer/support strip. The blank

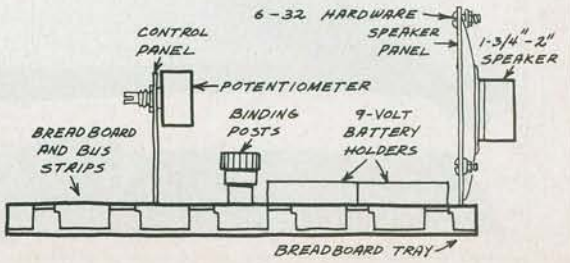

Fig. 5. A Hobby-Blox op amp prototyping system.

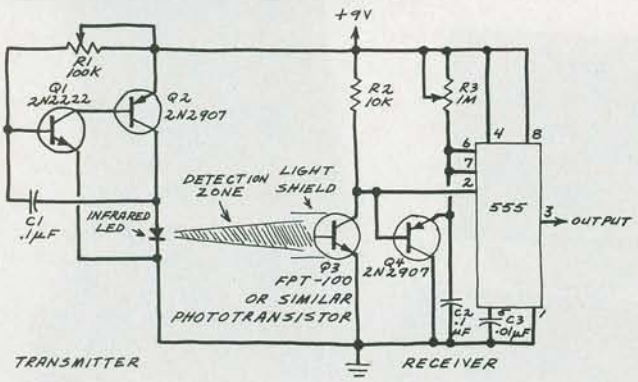

Fig. 6. An opto-electronic trigger for a camera or electronic flash.

panels are ideal for mounting joysticks, fiber optic connectors, piezo alerters, optoelectronic components, and other specialized devices and components.

A tray shorter than the main tray can be vertically mounted on the main tray by means of an adaptor strip (Fig. 4, right). This tray will accept all the Hobby-Blox modules and is therefore ideal for LED displays. It's also well suited for assembling optoelectronic circuits that require careful location or spacing of components such as infrared-emitting diodes and photodetectors.

Hobby-Blox Applications. Of the many applications for the Hobby-Blox system, two that I've found particularly handy are compact, self-contained, op-amp and CMOS prototyping systems. Figure 5, for example, shows one way to make an op-amp prototyping system. Dual-polarity, self-contained 9-V supplies are provided along with a speaker. The optional binding posts can be used when the system is powered by an external supply. A control panel with three potentiometers (10 kilohms, 100 kilohms, and 1 megohm) is also included. With a single 741 op amp and a dozen or so resistors, capacitors, diodes, and LEDs, this prototyping system can be used to assemble scores of different op-amp and comparator circuits. The system can easily be expanded by adding one or more additional trays to it with the help of extender clips or a bus strip.

The vertically mounted blank panel and short tray make possible many unique circuit applications. Figure 6, for example, shows an experimental optoelectronic detection circuit that will trigger a camera or an electronic strobe when an object enters the space between an infrared emitting diode and a phototransistor. With this arrangement you can take well-focused photographs of flying insects and projectiles automatically. Note that the camera will be triggered only when an object is directly between the LED and phototransistor.

In operation, a LED transmitter delivers a train of fast risetime pulses to the sensitive surface of the receiver's phototransistor. Transistor *Q4* and the 555 form a missing-pulse detector that is reset each time a pulse from the transmitter is received by the phototransistor. When an object blocks the path between the transmitter's LED and the receiver's phototransistor, the 555 completes its timing cycle and the output at pin 3 changes from high to low.

The receiver output can be connected directly to the trigger inputs of some cameras, but an inverter and a common ground may be necessary. Other cameras may require a relay (between pin 3 and +9 V) or SCR (pin 3 to gate) interface.

The system can be adjusted to ignore very fast moving objects by increasing the values of *R3* or *C2* in the receiver and slowing the frequency of the transmitter by means of *R1*.

You can quickly assemble the circuit in Fig. 6 using Hobby-Blox modules. One possible arrangement is to assemble the transmitter and receiver on breadboard strips installed in short trays. The assembled trays should then be installed facing one another in a main tray. The battery should be installed in a holder located between the two facing circuits. Any potentiometers and switches should be installed on one or two control panels located anywhere but between the two facing circuits. One method is to use extender clips to add a short tray that can contain any required control panels.

If you plan to photograph insects, place a flower or an appropriate bait between the facing circuits. Depending upon the time of year and your location, you may be able to attract flies, moths, beetles and other insects. Be sure to shield the phototransistor from external light with a length of heat-shrinkable tubing.

Going Further. Solderless breadboards can be used for finished circuits, but this becomes rather expensive if you build lots of different projects. Global Specialties has developed a simple but effective method for quickly transferring a breadboard circuit onto an etched circuit board. Shown in Fig. 7, this concept is based upon an etched circuit board that exactly duplicates the array of terminal holes in a plastic breadboard. A paper version of the circuit board (available in pads) allows experimenters to make new designs and layouts easily, and to keep a record of successful designs.

Global Specialties calls this clever concept The Experimentor System™. It's but one way to convert your circuits into permanent versions. Thanks to some very creative engineers, there are many effective methods for making permanent soldered and wire-wrapped circuits. If you're still building circuits using perforated boards and point-to-point soldered connections, you should take time to investigate the many new circuit assembly aids and hardware now available. ◇

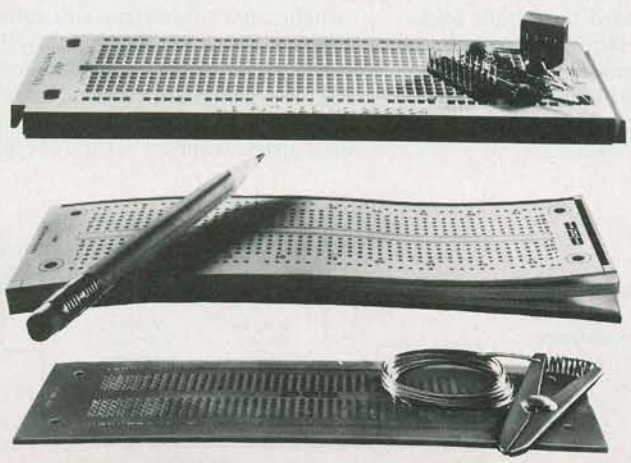

Fig. 7. Global's Experimentor System allows breadboard systems to be transformed quickly into permanent versions.